

DOCUMENT RESUME

ED 151 195

SE 023 971

AUTHOR Ross, William D.; Bridgmon, George H.
TITLE Plant Disease Control by the Use of Chemicals.
MP-27.
INSTITUTION Wyoming Univ., Laramie. Agricultural Extension
Service.
PUB DATE Jan 74
NOTE 48p.; For related documents, see SE 023 961-973;
Colored photographs will not reproduce well
EDRS PRICE MF-\$0.83 HC-\$2.06 Plus Postage.
DESCRIPTORS *Agricultural Production; Chemical Nomenclature;
*Disease Control; Environment; *Pesticides; *Plant
Pathology; Pollution
IDENTIFIERS *Wyoming

ABSTRACT

This document has been prepared as a reference manual providing information regarding plant diseases. The text concerns itself with the identification and development of infectious and non-infectious diseases and associated control measures. An appendix includes a glossary of plant pathological terms and a bibliography. (CS)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED151195

SE 023 971

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY
George Bridgman
TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC) AND
USERS OF THE ERIC SYSTEM."

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION
THIS DOCUMENT HAS BEEN REPRO-
DUCED EXACTLY AS RECEIVED FROM
THE PERSON OR ORGANIZATION ORIGIN-
ATING IT. POINTS OF VIEW OR OPINIONS
STATED DO NOT NECESSARILY REPRESENT
OFFICIAL NATIONAL INSTITUTE OF
EDUCATION POSITION OR POLICY

Plant Disease Control By The Use of Chemicals

MP 27

COLLEGE OF AGRICULTURE

AGRICULTURAL EXTENSION SERVICE

UNIVERSITY OF WYOMING—LARAMIE

JANUARY 1974



PLANT DISEASE CONTROL BY THE USE OF CHEMICALS

William D. Ross
Assistant Professor of Plant Pathology

George H. Bridgmon
Professor Plant Pathology, & Head of Plant Pathology and
Horticulture Section

The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by the Wyoming Extension Service is implied.

The Wyoming Agricultural Extension Service is an equal opportunity educational organization.

Issued in furtherance of agricultural Extension work, acts of May 8 and June 30, 1914, in cooperation with the U. S. Department of Agriculture. N. W. Hilston, Dean and Director, Agricultural Extension Service, University of Wyoming, Laramie 82071.

PREFACE

The plant pathology portion of this manual has been prepared for those that might have occasion to apply or recommend fungicides, nematocides and bactericides. The specific diseases have been selected for their importance to the agriculture of Wyoming.

Section IV, of this manual, the plant pathology portion, has been prepared as reference materials for those persons seeking information in regard to plant diseases. Although this is far from complete as a study of plant pathology or even of plant disease control in Wyoming it should be an aid and guide in the solution of many of the problems incurred while working with pesticides.

An appendix includes a glossary of plant pathological terms to aid in the study and a bibliography to indicate source material for further study, as well as sources from which some of the material was taken.

Information has been taken from many sources, including original publications, plant pathology texts, and chemical guides from other states. This has been edited to be useful under our conditions for Wyoming diseases.

It would be impossible to acknowledge all sources and individuals, but the authors are grateful to all their colleagues in plant pathology who have furnished such material or aided in the publication of this section.

W. D. R.

G. H. B.

TABLE OF CONTENTS

	<u>Page No.</u>
PREFACE	IV - 1
TABLE OF CONTENTS	IV - 11
PLANT PATHOLOGY	IV - 1
SECTION I Introduction	IV - 1
SECTION II Definition: What Constitutes A Plant Disease	IV - 2
A. Plant disease	IV - 2
B. Nature of infectious diseases	IV - 2
C. Nature of noninfectious diseases	IV - 2
SECTION III Infectious Agents	IV - 3
A. Fungi	IV - 3
B. Bacteria	IV - 3
C. Viruses	IV - 4
D. Nematodes	IV - 4
SECTION IV Identification of Plant Diseases	IV - 5
A. Signs	IV - 5
B. Symptoms	IV - 5
1. Necrotic	IV - 5
2. Distorted or impeded growth	IV - 6
SECTION V How Diseases Develop	IV - 7
A. Plant diseases increase in two basically different patterns	IV - 7
1. Some plant diseases spread slowly	IV - 7
2. Some plant diseases spread rapidly	IV - 9
B. Factors necessary for disease development	IV - 11
1. Temperature	IV - 11
2. Moisture	IV - 12
3. Other Factors	IV - 12
SECTION VI Control of Plant Diseases	IV - 13
A. Introduction	IV - 13
B. Non-chemical control	IV - 13
1. Selection of resistant varieties	IV - 13
2. Planting clean seed	IV - 14
3. Practicing good sanitation	IV - 14
4. Modification of environment	IV - 14
5. Crop rotation	IV - 15
C. Chemical control	IV - 15
1. Soil fumigation	IV - 16
a. Soil conditions desired for fumigation	IV - 16
b. Some uses for fumigants in Wyoming.	IV - 17
c. Care in fumigation	IV - 18
2. Seed treatment	IV - 18
a. Seed and seedling diseases	IV - 19
b. Diseases other than those of seeds and seedlings	IV - 19

TABLE OF CONTENTS (continued)

	<u>Page No.</u>
3. Seed treatments for Wyoming	IV - 19
a. Wheat and barley.	IV - 19
b. Oats	IV - 20
c. Sorghum	IV - 20
d. Sugarbeets	IV - 21
e. Corn (field)	IV - 21
f. Beans	IV - 21
g. Potatoes	IV - 21
h. Vegetables and ornamentals (in general)	IV - 21
4. Feed grain treatment for storage . . .	IV - 22
a. Storage of high moisture barley, corn, oats, sorghum, and wheat. (Preservation against fungi and bacteria)	IV - 22
b. Storage of high moisture corn (Preservation against fungi) . . .	IV - 22
5. Foliar treatments	IV - 22
6. Foliar treatments for Wyoming	IV - 23
a. Beans	IV - 23
b. Corn	IV - 23
c. Potatoes and tomatoes	IV - 23
d. Apples, crabapples, cotoneaster, mountain ash, and pears	IV - 23
e. Apples - scab	IV - 23
f. Apples - cedar-apple rust	IV - 24
g. Ornamentals, shrubs and trees . . .	IV - 24
h. Vegetables and fruits (general) . .	IV - 24
SECTION VII Plates of Symptoms and Signs	IV - 26
SECTION VIII Plant Pathology Glossary	IV - 35
SECTION IX References	IV - 38

LIST OF FIGURES

<u>SECTION</u>		<u>Page No.</u>
V	Fig. 1. Disease Cycle of Bunt	IV - 8
	Fig. 2. Disease Cycle For Bean Rust	IV - 10
VII	CE 3 Some common vegetable diseases	IV - 27
	CE 6 Curcubit diseases	IV - 28
	CE 8 Vegetable diseases II	IV - 29
	CE 13 Small grain diseases	IV - 30
	CE 14 Ornamental diseases	IV - 31
	CE 17 Corn diseases	IV - 32
	CE 18 Shade and forest tree diseases	IV - 33
	CE 27 Apple diseases	IV - 34

PLANT PATHOLOGY

SECTION I

Introduction

As a pesticide user often you will be asked to identify the cause for a plant disease and to treat the disease with an appropriate chemical. Unfortunately, there is a widespread assumption that all plant diseases can be controlled with some type of chemical application. This assumption is not true, and failure to recognize this fact may lead to misuse of a pesticide.

Fungicides, bactericides and nematocides are designed to reduce losses in crops or damage to ornamental plants caused by types of diseases known as infectious diseases. Pesticides will do no good if applied to plants in order to cure injuries or noninfectious diseases. Also, many infectious diseases are either not effectively controlled with chemicals or are better controlled by other means.

When one is considering the chemical treatment of a plant problem the following questions should be answered: Is an infectious disease involved? What is causing the disease? Is a chemical application called for? What kind of chemical should be used? How and when should the chemical be applied? Often you may want someone to help you make some of these decisions, but each of the above questions should be answered before applying a pesticide. The information that follows in this section should help you to answer these questions.

SECTION II

Definition: What Constitutes a Plant Disease?

- A. Plant disease is not a condition, but rather a process (14). A specific agent, such as a pathogen, unfavorable weather, mechanical or chemical injury may incite abnormal processes in plants which leads to inadequate growth, undesirable properties or displeasing appearance of the plants.
- B. The Nature of Infectious Diseases.
1. Once an infectious disease begins, the process is continuous until the cause of the disease (causal agent) is removed, or environmental conditions no longer favor its development.
 2. The causal agents of infectious diseases (pathogens) grow within plant tissue causing disruptions of normal physiological functions. Also, pathogens may move from infected plants to new, uninfected plants as disease progresses. As a few infections grow to billions and the billions of agents start moving to new plant hosts, a disease epidemic arises. As a pesticide user your primary concern is to reduce or delay epidemics sufficiently to allow crop success.
 3. Pesticides are designed to stop the growth of pathogens on or within host plants and to protect healthy plants from pathogens that attempt to attack them. However, chemical treatments for arresting many plant pathogens are not presently available.
- C. The Nature of Noninfectious Disease
1. Physiological disorders are incited by such factors as unfavorable weather, mechanical damage, nutrient deficiencies, excess salts, and toxic chemicals. Actually about 70% of all diseases or disorders belong to this group.
 2. Causal agents of noninfectious diseases do not grow within plants and do not move from diseased plants to infect healthy plants. Thus, pesticides cannot stop the increase in damage done by noninfectious diseases.

SECTION III

Infectious Agents

Certain kinds of fungi, bacteria, viruses and nematodes clearly are the most important and numerous agents of infectious plant disease. Far fewer diseases are caused by the higher seed plants, i.e. dodder and mistletoes, viroids (virus-like particles causing spindle tuber of potato), Mycoplasma (causing aster yellows diseases and corn stunt), and Actinomycetes (causing potato scab). The four major types of causal agents are described below.

- A. Fungi (fungus, singular) cause more plant diseases than any other type of infectious agent. Fungi must obtain all of their organic foods from higher plant and animal materials. Some fungi grow only on dead material (saprophytes), others grow only on live plants (obligate parasites) and many are able to grow both as saprophytes and parasites.

Most fungi grow as fine, string-like filaments (hyphae). This physical form of fungi allows them to mechanically and chemically penetrate intact plant surfaces. Thus, injuries or natural openings in plant surfaces are not always needed for fungal infection, but injuries often increase severity of disease.

Most fungi produce spores which have a function similar to seeds of green plants. Spores may be dispersed by wind, water, farm equipment, insects, plant seed; and each spore may germinate to cause a new infection. Also, some fungi may survive for long periods (several months or years) as resting spores in soil or plant debris.

Individual hyphae and spores can be seen only with the aid of a microscope. However, as fungi grow into masses of hyphae (mycelium) or masses of spores, these masses may become visible to the naked eye. Such visible masses of fungal tissue constitute the signs of plant disease discussed below.

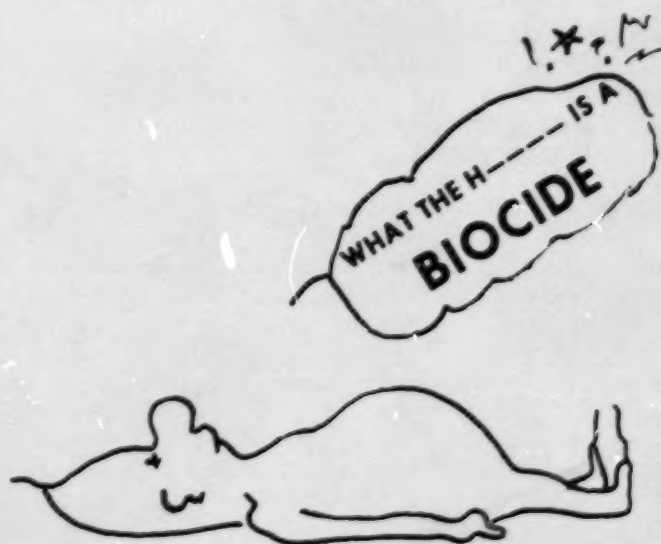
- B. Bacteria are the second most important group of plant pathogens. Plant pathogenic bacteria usually obtain all of their organic food from higher plants. All agricultural soils contain many kinds of saprophytic bacteria as well as bacteria which make their own organic matter.

Bacteria do not grow as hyphae but remain as single cells. Growth is by multiplication of cell numbers. Because bacteria lack a physical form which allows them to firmly anchor themselves to plant surfaces,

they usually require injuries or natural openings in plant surfaces in order to enter their hosts.

Bacteria are much smaller than fungi and can be seen only with a microscope. One common sign of many bacterial diseases is the oozing of a viscous, slimy mass of large numbers of bacteria from infected tissues.

- C. Viruses cause a large number of plant diseases. They are too small to be seen with a light microscope. All viruses are obligate parasites because they lack the chemical means for utilizing organic matter by themselves. They increase in number by taking over the control of host plant cells and directing the plant cells to manufacture new virus particles. Since virus particles are helpless outside of host cells, they have no means of penetrating intact host surfaces. They must be introduced into plants by mechanical injuries, including those caused by insects or man; or they may be transmitted through seeds, tubers or grafts. Most virus diseases are identified by characteristic symptoms (see below) which they cause in specific indicator plants.
- D. Nematodes are small eelworms which may attack any part of a plant host depending on the species of nematode involved. Most nematodes feed only on microscopic plant and animal life in the soil, but more than 1000 species cause plant disease. Plant pathogenic nematodes produce stylets (hollow, sharp tubes) which they insert into plant cells for feeding. Some nematodes lay eggs in plant tissue, some lay them directly in soil and others first lay their eggs in soil and then the body of the female forms a protective cyst around the eggs. Nematodes are quite small, but can be seen with low power microscopes.



SECTION IV

Identification of Plant Diseases

Symptoms and Signs: Since diagnosis is one of the steps in determining if one is dealing with plant diseases, one must learn to distinguish diseases by their characteristic signs and symptoms. Familiarity with the names and characteristics of these is essential in the study of plant pathology. Often, symptoms and signs appear together in a diseased plant.

- A. Signs are structures of the pathogen itself occurring in connection with the disease. Examples of this are: Mildew, Plate CE 3, No. 7; Smut, CE 17 No. 4; Rust, CE 13, No. 9.*
- B. Symptoms are the evidence of sickness or injury of the plant itself (such as dead spots in leaves or bark, rotten spots in fruits or tubers, swellings on roots or branches of clustered branches, unnatural color or habit, vascular discoloration, delignification, phloem necrosis, enlargement of cells, abnormal multiplication of cells, suberization.)

The symptoms can be most conveniently divided into two groups; namely, necrotic and distorted or impeded growth.

1. Necrotic: Symptoms showing degeneration and death.

Degeneration symptoms (dying cells)

Yellowing (localized, generalized). See Plate CE 3, No. 4,
Water-soaked areas

Wilting or flagging. Plate CE 3, No. 3.

Morbid symptoms (dead cells)

Scorch or burn (sudden death and browning of large indefinite areas). Plate CE 27, No. 9.

Firing (drying and dying of leaves)

Streaks and stripes (elongated narrow parallel necrotic lesions especially associated with leaf veins) Plate CE 13, No. 6.

Net necrosis (irregular interlocking necrotic lines)

Blight (foliage or blossoms suddenly killed by pathogenic organisms). Plate CE 27, No. 9.

Blast (blighting or sudden death of young buds, inflorescences or young fruit)

Die-back (dying backward from the tip of twigs or branches of trees and shrubs usually during dormant period).

* See Section VIII Plates for Symptoms and Signs of Plant Diseases

Spot (development on foliage of circular dead areas)
 Plate CE 8, No. 7.

Shot hole (dropping out of necrotic tissue leaving circular holes)

Pitting (dying of fleshy tissue beneath intact epidermis of fruits and tubers resulting in definite depressions)

Rot (dead tissue in a more advanced stage of degeneration)
 Plate CE 27, No's. 1 and 2.

Mummification (rapid drying out of rotted fruits resulting in a darkened, wrinkled hard mass called a mummy). Plate CE 27, No. 4.

Canker (sunken necrotic lesions in the cortical tissues of the stems, tubers or roots). Plate CE 14, No. 9.

Damping-off (Rapid rotting of the base of the stems of seedlings resulting in the falling over of the seedling). Plate CE 14, No. 1.

Leak (soft rot in which freed juices leak out)

Bleeding (chronic flow of sap from wounds often accompanied by an odor of fermentation)

Scald (blanching of the epidermis and adjacent tissues resulting in a pale or dirty brown color).

Gummosis (diseased cells and cell walls are converted into viscid gum which ooze from wounds)

Resinosis (abnormal exudation of resin).

2. Distorted or impeded growth: Symptoms resulting from over or under development.

Chlorosis (partial failure of development of green color such as in yellows or mosaics). Plate CE 17, No. 3.

Abortion or atrophy (halting in the development of an organ after partial differentiation)

Suppression of growth (complete prevention of development of organs)

Extiolation (spindly growth)

Dwarfing, Rossetting, etc.

Abnormal organs (development of organs usually not present or present in rudimentary state)

Premature growth (development of shoots from buds which should remain dormant)

Tissue transformation (transformation of tissues or organs from one kind or type into another)

Abnormal coloration (organs and tissues of a color not usual for them)

Gigantic growth (tumor formation, callus, curl, scab, CE 8, No. 9, fasciation or gall on root knot, CE 3, No. 8 or CE 15, No. 2.)

SECTION V

How Diseases Develop

Now you are familiar with several examples of pathogens and the damage they cause to individual plants. With the exception of relatively few high-value ornamental plants, pesticides for disease control are intended to treat large populations of plants. Pathogens from a few plants can develop large amounts of inoculum and infect whole populations of susceptible hosts. This section describes how pathogens increase and infect large numbers of plants.

In order for pathogens to survive continuously, they must complete a number of regularly occurring steps in development, i.e. spore production, dispersal, infection and resting stages. These steps are repeated in cycles. A very revealing way to describe disease development is to draw a disease cycle. Thus, two basic patterns of disease development are described below using two specific disease cycles to represent the two basic patterns.

A. Plant diseases increase in two basically different patterns (14).

1. Some plant diseases spread slowly to new hosts and do not substantially sweep through fields or regions during a single growing season. The increase is similar to the way money increases when earning simple interest; i.e., the capital increases only at the end of each year.
 - a. Examples of this kind of disease include those where pathogens generate inoculum (fungal spores, bacterial cells, virus particles, nematode cysts, etc.) during the growing season, but disperse the inoculum to new plants only at the end of the season or the beginning of the next growing season.
 - (1) For example, consider covered smut (bunt) of wheat or barley (Fig. 1). Infection of new host plants is largely restricted to seeds and seedlings at planting time. Following seed infection, the fungus grows upward inside of the plant for most of the growing season. As the grain begins to form, the fungus grows into the developing seeds and produces tremendous amounts of spores in place of the seeds. At the time of combining and subsequent handling of seed, many infected seeds break open, and the spores are mixed with healthy seeds and, less importantly

BUNT SPORES
INFEST
SEED AND
SOIL

1

UNTREATED SEED

CHEMICAL CONTROL

TREATED SEED

SEED TREATMENT
REDUCES IN-
FECTION BY
BOTH SEED-
AND SOIL-
BORNE SPORES

6

UNTREATED SEED
IS INFECTED
BY SEED- AND
SOIL-BORNE
SPORES

2

THRASHING CAUSES MANY
INFECTED SEEDS TO BREAK
OPEN AND SCATTER BUNT
SPORES TO HEALTHY SEED
AND SOIL

5

PLANTS ARE
NOT INFECTED

7

CLEAN, FULL
HEADS ARE
PRODUCED

8

4

AT HARVEST TIME
MANY INFECTED SEED
HEADS ARE PACKED
WITH BUNT SPORES

3

BUNT FUNGUS GROWS
WITHIN PLANTS FOR
MOST OF THE SEASON.
FEW IF ANY NEW PLANTS
ARE INFECTED AT THIS
TIME.

FIG. 1. DISEASE CYCLE OF BUNT

in Wyoming, are also dispersed over the soil surface. Therefore, spread of disease inoculum to new seed and to soil occurs only once a year, just like money being earned by simple interest.

- (2) After considering important information in the disease cycle of bunt (Fig. 1), the following is an example of the reasoning leading to bunt control: An infectious disease is involved and will spread to next year's crop if control measures are not implemented. Bunt is a disease with a slow rate of infection during the growing season, so measures which slow the rate of spread, such as protective foliar fungicides, will do little good. Sanitation in the form of soil fumigation can be effective with many soil-borne diseases with slow infection rates, such as nematodes in sugar beets and many seedling diseases. However, the main source of bunt spores for infection in Wyoming is the seed, and little if any control would be obtained by soil fumigation. The rate of disease spread is determined by how many bunt spores infest healthy seed that will be planted next year. The best way to get clean seed is to kill bunt spores which have contaminated the seed during combining and handling; the best way to do this is by chemically treating the seed surface. (Fig. 1).
- (3) Many other plant diseases also spread slowly to new hosts; i.e. they do not substantially sweep through fields or regions during one growing season. However, for many, no practical chemical control is known. Examples include: Fusarium root rot of bean, ring rot of potato, bacterial wilt of alfalfa, Verticillium wilt of potato, potato scab, probably Rhizoctonia diseases of sugar beets, potato and beans, wheat streak mosaic virus of wheat, leaf roll virus of potato, and dwarf mistletoe on pine.

2. Some plant diseases spread rapidly to epidemic proportions in a short period of time. The increase in disease is similar to the way money grows when earning compound interest; i.e. the capital increases continuously throughout the year.

- a. Examples of this kind of disease include diseases where inoculum generated at one small spot in a field or in a cropping region spreads (usually by wind or insect vectors) to infect entire fields or regions.
- (1) For example, the bean rust pathogen is nearly always present in small amounts in bean-growing areas (Fig. 2). However, in those exceptional years in Wyoming when conditions of free moisture and high humidity occur repeatedly, this pathogen may explode with massive doses of spores. Within a few days or weeks small areas of infection increase to many square miles.

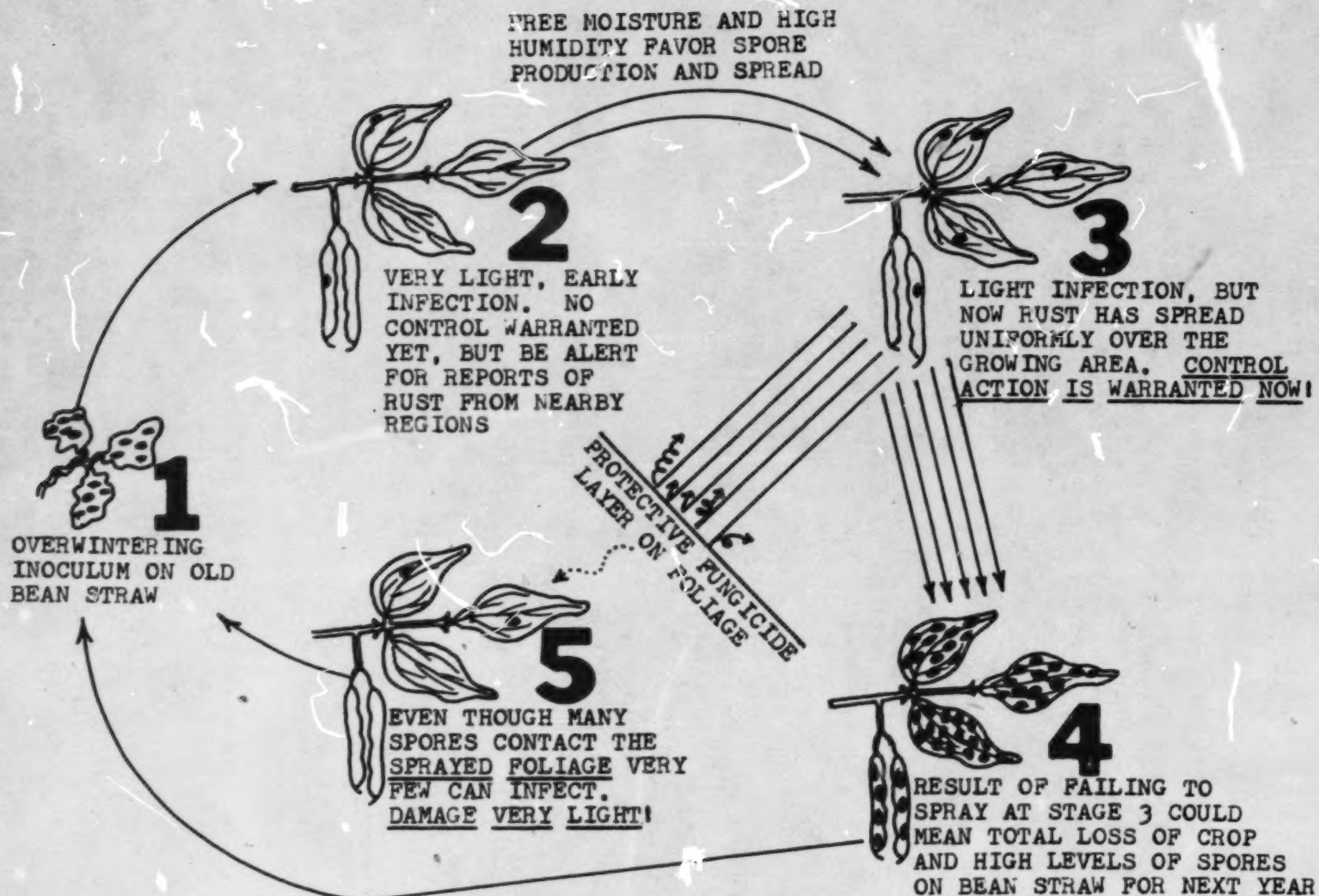


FIG. 2. DISEASE CYCLE FOR BEAN RUST

- (2) After studying the disease cycle of bean rust (Fig. 2), the following is an example of reasoning leading to the control of bean rust: Bean rust is an infectious disease. Infection rates during the growing season are very rapid when weather conditions favor rust; i.e. rust can sweep through many square miles in a short time. Thus, measures used to control diseases with slow rates of infection; e.g. seed treatment, removal of infested plant debris, soil fumigation, will not slow the rapid rate of spread of this aerially-dispersed disease enough for good control.

Luckily, in Wyoming the humidities are usually too low to allow bean rust to generate the rapid rates of infection that it is capable of generating under humid conditions. However, in those exceptional years when bean rust begins to build up and spread, the only practical way to control the rate of infection is by applying a foliar spray or dust. The object is to protect the foliage with a layer of chemical that will prevent wind-borne spores from infecting the foliage even though spores contact the plants.

Other diseases that are capable of spreading very rapidly include stem and leaf rusts of cereals, southern corn leaf blight, early and late blights of potato and tomato and a number of other leaf spot diseases.

- (3) From the discussion of the two disease cycles presented above it is apparent that a knowledge of the time needed for rapid spread and the factors promoting that spread is essential for successful disease control.

B. Factors necessary for disease development

There are three primary conditions necessary for the development of an infectious disease and disease epidemics.

1. Abundant development of parasite.
2. Prevalence of susceptible host.
3. Favorable environmental conditions for both to develop.

The control measures, whether by pesticides or other measures, should discontinue the development of the parasite, reduce the susceptibility of the host, and/or make conditions unfavorable for the parasite to develop all without removing conditions favorable to the host. Now let us consider condition No. 3 in more detail to see just what environmental conditions are favorable for disease development in Wyoming. In this consideration we will see that conditions most favorable for development of one disease may be very unfavorable for a second.

1. Temperature:

a. High

In Wyoming white mold of beans becomes extensive in the heat of the summer, but causes much less damage during cool periods.

b. Low

Yellow stripe rust of wheat and barley is favored by fairly cool weather and often occurs in southeastern Wyoming.

2. Moisture:

a. High

In general fungi and bacteria which parasitize plants are favored by wet conditions. With some organisms like the downy mildews (such as late blight of potato), high humidity favors the production and liberation of spores.

Free moisture is also helpful in the dissemination of these spores (dripping dews and splashing rains). Infection of some plants does not occur unless there is a film of free moisture for a period of time, i.e. bean rust, see Fig. 2 between steps 2 and 3, and wheat stem rust.

b. Low

The powdery mildews are favored by low humidity; this is the exact opposite of downy mildews. Potato scab which is often severe in Wyoming is favored by our dry soils. The seed or soil borne smuts illustrated by life cycle, Fig. 1, infect much better at moderate soil moisture than with either high or low moisture.

3. Other Factors:

There are many other factors like light, wind, pH, fertility and soil type that determine conditions necessary for disease development but seem beyond the scope of this manual.

SECTION VI

Control of Plant Diseases

A. Introduction

The control of plant diseases is the ultimate objective of every plant pathologist. His concern is to reduce or perhaps to eliminate the economic or aesthetic loss it causes. Principles of plant disease control have been classified variously but most often under the following four headings as:

1. Exclusion: Measures to prevent introduction of an organism into an area where it does not exist. An example is quarantines by a country, state, or county. Actually, this might even be considered on an individual farm where the farmer or operator would be so careful in his management or seed selection that he would avoid bringing the pest or organism onto his property.
2. Eradication: The elimination of a pathogen from a host or area. This elimination is usually very difficult if the inoculum is extensive or the area is large.
3. Protection: The prevention of plant diseases by chemical prophylaxis or environmental manipulation.
4. Resistance: The use of plants not susceptible to the disease. They are usually developed through breeding and selection programs. Immunity or total resistance is often unobtainable and many of the resistant varieties have a degree of resistance that allows the plant to grow in spite of contact with a pathogen.

B. Non-chemical control

Most non-chemical control measures involve the use of many integrated measures to minimize the disease. The following discussion uses Wyoming diseases as examples. Many of these may be classified in more than one of the four broad categories of control principles presented below. Probably 90% of all plant diseases in Wyoming may be controlled or avoided by means other than chemical control.

1. The selection of resistant or tolerant varieties of the crop to be planted. An example of this might be the selection of UI 114 Pinto beans which is resistant to common mosaic virus.

2. Planting clean seed or planting materials. This might be carried out in a number of ways:

- a. Buying certified seed. Seed that has been inspected by impartial agencies, i.e. University of Wyoming and other Seed Certification Services, and no diseases were found.
- b. Maintaining your own seed production plot (often isolated) on a small acreage where roguing and constant observation can be made to maintain disease-free seed stock.
- c. Purchasing seed grown in known disease-free areas, i.e. purchase of blight-free, California bean seed.
- d. Avoid introduction of pathogens onto a field by treating the seed propagation materials with heat, hot water, or steam, or combinations thereof.

3. Practicing good sanitation.

Avoiding the sources of, or reducing inoculum that might infect your crops. Examples of such control measures are enumerated below:

- a. Destroying debris, i.e. potato or vegetable cull piles containing diseased tubers or plants.
- b. Destroying by burning or removing from the field straw or plant parts containing infectious organisms. An example of this might be the pruned parts of an apple or crab apple with lesions containing the fire blight bacterium, or killing potato vines with fire prior to harvest.
- c. Sorting, screening, blowing, hand picking or roguing of seed lots or growing crops. This can be applied to seeds, nursery plants and actually any plant parts used for propagation. The method is applicable to cereal crops in the removal of smut balls, ergot bodies, and even light shriveled kernels which might be infected. It also applies to potatoes, beans and many garden crops.
- d. Removal of weed hosts on alternate hosts. Various plant pathogens have more than one host. This is true of many of the rusts, smuts, and mosaic diseases caused by viruses. An example of this situation in Wyoming is the reservoir of the bean mosaic virus constantly carried in the sweet clover that is often found along field borders and ditch banks.
- e. Treatment of tools, knives or machinery, i.e. cultivating equipment, with steam or hot water to remove infestations of pathogenic organisms.

4. Modification of environment

There are some practices which prevent or minimize disease losses

by modifying the environment. Such practices as avoiding bruising during harvesting, or careful handling to avoid injuries or wounds may reduce infections. Environmental-modification practices including, early or late harvesting, early or late planting, spacing of crops, irrigation and fertilizing practices, may reduce disease. Specific examples of these practices are:

- a. Plant winter wheat late to avoid fall spread of wheat streak mosaic virus and possible loss of crop.
- b. Choose row or surface irrigation in preference to overhead irrigation to avoid spreading the organism causing bacterial blight of beans.
- c. When the alfalfa leafspot becomes too prevalent, immediately start cutting and harvesting to prevent hay quality loss through loss of lower leaves.
- d. Wider spacing of crops or lower planting rates will minimize damage done by humidity loving pathogens, i.e. mildews on most crops and white mold of beans.
- e. Keep newly stored potatoes at a high enough temperature to promote "corking off" and thus prevent infection later. Then lower the temperature for storage to permit better keeping of the tubers and minimal organisms spread and growth.

5. Crop rotation

This is a very old method to control plant diseases as it was soon found that alternating non-host plants with host plants reduced the incidence of certain pathogens in a field. This is particularly effective against soil invaders that do not normally persist for a long period in the soil.

C. Chemical control

After a disease problem has been identified and a chemical application has been determined to be the best control, a chemical must be chosen. Many publications are available which recommend chemicals for plant disease problems. Extension bulletins from Colorado, Kansas and Montana (6, 8, and 5) contain recommendations which cover most problems found in Wyoming. Caution must be taken to use only the latest recommendations because federal restrictions on pesticides change frequently. It is your responsibility to know if the chemicals you use have federal clearance. When you are uncertain about clearance of restrictions on a chemical, the latest information can be obtained from the County Agricultural Agent. The following information can be found in two different federal publications that are maintained at the University of Wyoming:

Annotated Index of Registered Fungicides and Nematocides; Their Uses in The United States. Pesticides Regulation Division, ARS, U.S.D.A. This volume includes information on the following:

Use (Type of crop).
Rate of application.
Time of application.
Frequencies of repeat applications.
Tolerances allowable in the end product.
Waiting periods between last use and harvest.

EPA Compendium of Registered Pesticides Vol. II.

Fungicides and Nematocides. Publications Branch of the Pesticides Regulation Division. This volume includes the following information:

Tolerances allowable in end product.
Maximum application rates allowed.
Waiting periods between last use and harvest.
Label information.

Chemicals for plant disease control may be classified in many different ways; i.e., by class of chemical, disease controlled, application method used, etc. The chemicals are classified below according to the general types of application.

1. Soil fumigation

The purpose of soil fumigation is to lower the amount of initial inoculum of pathogens before planting a crop. This type of control is effective against only those diseases that spread from plant to plant fairly slowly during the growing periods of the hosts; i.e., those that increase like capital earning simple interest. Fumigation can be used for those organisms that persist in the soil for too long a period of time to be controlled by a practical rotation schedule. Fumigation is relatively costly and usually is applied successfully only to high-value crops or where more than a single fungal, nematode, insect or weed pest are controlled simultaneously.

a. Soil conditions desired at the time of fumigation.

- (1) Tilth -- Fumigants either are volatile toxins or generate volatile toxins which must be able to penetrate and diffuse through soil to be effective. Thus, soils should be cultivated to the depth to be controlled wherever possible.
- (2) Organic matter -- Fumigants are very actively adsorbed and absorbed by large pieces of organic matter. Thus, for best distribution of fumigant, plant debris should be largely decayed before fumigation.
- (3) Moisture content -- Too much moisture blocks movement of fumigants, but most fumigants need some moisture for best results. Soil should contain adequate moisture for seeding, but should not be saturated.

- (4) Temperature -- Generally fumigants are most efficient at soil temperatures between 50 and 85 degrees F.
- (5) Waiting periods -- Most fumigants are highly toxic to living plants. Treated sites must be allowed to aerate from several days to more than a month depending on the soil type and chemical.

b. Some uses for fumigants in Wyoming.

- (1) Sugarbeets (nematodes). Rotations of three years or greater will usually lower populations of pathogenic nematodes to levels which cause little or no economic loss. However, where the possibility of serious nematode damage is suspected, fields should be sampled by a qualified person to see if populations of pathogenic species are high enough to warrant fumigation. Three chemicals commonly used in Wyoming are:

- (a) Dichloropropene (Telone^{R*}) (or combinations with chloropicrin).
- (b) Dichloropropene - Dichloropropane mixtures (D-D).
- (c) Aldicarb (Temik^R)

Consult the fumigant supplier for time, equipment and procedures for application.

- (2) Fungal diseases. At the present time there are few crop diseases in Wyoming, other than nematode diseases of sugar beets, that are treated with fumigants unless weeds and/or insects are the primary concern. The following include some of the more limited types of fumigant applications for fungal diseases in Wyoming.
 - (a) Home gardens, greenhouses (when vacant) and nursery beds. Treatments in this category are primarily for damping-off and seedling diseases. Also, Verticillium wilt of potato, tomato, flowers, etc. may warrant fumigation. Fumigants that can be used singularly or in combination include: Vapam^R, chloropicrin, Mylone^R, methyl bromide, Vorlex^R, formaldehyde and carbon disulfide. A tarp, plastic sheet, or other type of cover is advisable following fumigation with the more volatile compounds like methyl bromide, but other means of cover, such as water seals or surface compaction, may suffice with some chemicals.

* Trade names designated by the symbol, (R), are used in certain instances to simplify information.

- (b) Dutch Elm Disease (DED). As soon as a tree has been diagnosed as having DED it should be isolated from adjacent healthy trees. This can be done physically by digging a trench or by fumigating a thin line of soil between the diseased and healthy tree in order to kill all roots from the two adjacent trees which are likely to form root grafts. This may be done with a soil drench of Vapam^R applied to holes drilled in the soil between the trees. See the label of the product for rates and means of application.
- (c) Eradication of soil-borne tree diseases before re-planting. Soil infested with Armillaria mellea, Phytophthora sp. or Verticillium fungi should be fumigated before replanting. For orchard trees, remove old stumps and roots, level the site and erect a ridge of soil to form a basin. For Armillaria mellea the basin around each tree should be at least 20 by 20 ft. Treat with Vapam^R when the soil temperature is 50 to 90 degrees F., and add enough water to penetrate to the depth of the roots. See label for limitations.

Carbon disulfide may be applied when the sub-soil is dry and broken to a depth of 14 in. Injection can be made to a depth of 7 to 8 inches. Tamp each hole to close it, and wait at least 30 days.

- c. Care in fumigation. Extreme caution must be taken to avoid injecting or inhaling fumigants, and protective eye goggles, clothing and gloves should be used to avoid skin contact. Fumigants are corrosive, and application equipment should be washed with kerosene or fuel oil. The following are human toxicity ratings for common fumigants:

Chemical	Oral	Dermal
Chloropicrin	Highly toxic	Severe reaction
Formaldehyde	Low order toxicity	Mild reaction
Methyl bromide	Highly toxic	Severe reaction
Mylone ^R	Low order toxicity	Mild reaction
Vapam ^R	Low order toxicity	Moderately toxic
Vorlex ^R	Moderately toxic	Mild reaction

Carefully follow instructions on the pesticide labels. Also, literature on equipment and procedures for application can be supplied by the manufacturer.

2. Seed treatments -- **CAUTION:** Any seeds or seed pieces treated with any chemical for the purpose of protecting them from disease should never be used for food, feed, or production of oil. All containers for treated seed should be plainly labeled Poison.

Dyes are available, and commercial products include dyes that lend obvious color to treated seeds so they can be easily recognized as treated. Such dyes should always be used.

Seeds are treated with chemicals to combat two broad categories of plant diseases:

- a. Seed and seedling diseases -- From the time seeds first take up water until the young plants have passed through the seedling stage, they are highly susceptible to infection by a whole complex of pathogens which cause damping-off diseases. Damping-off involves seed rot and/or decay of young, emerging stems resulting in death of seeds and seedlings. One major objective of chemical seed treatment is to protect seeds and young seedlings through the critical germination and post germination processes. After seedlings achieve a certain maturation damping-off is far less likely to occur.
- b. Diseases other than those of seeds and seedlings. Although seed and seedling pathogens attack most crop plants, there are a few pathogens that are seed and/or soil-borne that specifically attack only one or a few types of crop plants. Examples are the smut pathogens that infect cereals (Fig. 1.). Smuts attack seeds and young seedlings, but damage is not realized until harvest.

Most chemicals used as seed treatments act only at the surfaces of seeds and in the nearby soil. However, some chemicals penetrate the seed and eradicate pathogens within the seed and within developing seedlings. Those chemicals that disperse throughout the plant tissues are called systemic chemicals. Two examples of systemic seed treatments are chloroneb (Demosan^R) used on beans, and carboxin (Vitavax^R) used to eradicate loose smut from wheat and barley.

3. Seed treatments for Wyoming. Below are listed a number of chemicals cleared for use on major crops in Wyoming. No attempt was made to recommend specific chemicals, but rather the most commonly used chemicals are listed alphabetically.

a. Wheat and barley

Seed and seedling decay and covered smut (bunt)

Maneb in combinations with captan, HCB, PCNB or thiram.
PCNB
Polyram
Res-Q^R (captan, maneb and HCB)
Terra Coat Products (Terraclor^R and Terrazole^R)
Thiram (Arasans^R)
Zinc ion-maneb Complex

Seed and seedling decay and covered smut plus loose smut

Carboxin (Vitavax^R) Do not use treated crop as food or feed. Do not graze treated crop.

Covered smut

Copper carbonate
Copper sulfate
Sodium dimethyldithiocarbamate

Seed and seedling decay (not for smuts)

Captan in combinations with maneb, zineb, HCB and PCNB
Zineb (21%) plus captan (22%)

b. Oats

Seed and seedling decay and covered smut (bunt)

Maneb in combinations with captan and HCB
PCNB
Polyram

Covered smut (bunt)

Paraformaldehyde

Seed and seedling decay (Not for smuts)

Captan
Zineb (21%) plus captan (22%)

c. Sorghum

Seed and seedling decay and covered kernel smut

Captan in combinations with zineb and PCNB
Copper carbonate
Diazoben (Dexon^R)
Hexachlorobenzene
PCNB in combination with Terrazole^R

Loose and covered kernel smuts

Thiram

Seed and seedling decays

Chloranil
Dichlone (Phygon^R)
Captafol (Difolatan^R)
Terrazole^R plus PCNB
Zineb (21%) plus captan (22%)

Covered Smut

Sodium dimethyldithiocarbamate

d. Sugarbeets

Seed and seedling diseases and Aphanomyces

PCNB
Terrazole^R plus PCNB

Seed and seedling diseases

Captan
Diazoben
Dichlone
Thiram
Zineb (21%) plus captan (22%)

e. Corn (field)

Seed and seedling diseases

Captan
Chloranil
Dichlone
Terrazole^R
Maneb
PCNB
Captafol
Thiram
Zineb (21%) plus captan (22%)

f. Beans (field)

Seed and seedling diseases

Captan in combination with maneb, zineb and HCB
Chloroneb
Chloronil
Maneb in combination with captan and/or HCB
Terrazole^R plus PCNB
Zineb (21%) plus captan (22%)

g. Potatoes

Seed-piece treatments

Captan -- Damping-off, seed decay, Verticillium wilt.
Maneb -- Fusarium decay
Polyram -- Fusarium decay, seed-borne scab.
Zineb -- Fusarium decay
Zinc Ion-Maneb Complex -- Seed-borne scab and Fusarium decay

h. Vegetables and ornamentals (in general). Below are listed a few broad-spectrum chemicals for seed and soil treatments

to combat damping-off and seedling diseases of many vegetables and ornamentals.

Captan
Chloranil
Diazoben
Dichlone
Thiram

4. Feed grain for storage. Recently methods have been devised to control losses in feed grains stored with high moisture. Losses in high-moisture grain result from reduction in quality and generation of toxic products caused by fungi and bacteria. A good overview of this subject including control procedures is given in the 1972 fall issue of Farm Technology/Agri-Fieldman (3).

Four chemical products presently cleared for treatment of high-moisture grains for animal feed storage are given below:

- a. Storage of high-moisture barley, corn, oats, sorghum, and wheat (Preservation against fungi and bacteria). One must use a carefully-calibrated, metered type applicator. Dosages depend on moisture content and the manufacturer's dosage table should be followed. Use only on grain to be utilized as animal feed. Do not use on grain that might be used for seed, malting or human consumption.

Acetic acid-propionic acid mixture
Acetic acid-propionic acid-benzoic acid mixture
Propionic acid

- b. Storage of high-moisture corn (Preservative against fungi). Use only on corn to be utilized as animal feed.

Ammonium isobutyrate

5. Foliar treatments. Chemicals are applied to foliage of plants to provide a protective layer for excluding pathogens (Fig. 2) or, when systemic chemicals are used, to eradicate pathogens from infested leaves and stems. Correct timing of application as well as choice of the proper chemical are essential for good control. Also, chemicals applied to control plant disease, unless systemic, must cover susceptible plant parts quite thoroughly. Plant pathogens move around on plant surfaces less than insects, and probably will not contact a pesticide unless the chemical thoroughly covers the plant surface. As new, unprotected foliage is produced during the presence of viable pathogens or when rain showers remove foliar protectants, reapplications are often needed. Never use spray equipment for applying disease-control chemicals that was previously used to spray herbicides or other phytotoxic compounds. Do not use unlabeled chemicals (for example sulfur) without knowing percentage

active ingredient or without having pesticide label information for that particular compound.

6. Foliar treatments for Wyoming. Below are chemicals that have been cleared for use on some of the crops and ornamentals found in Wyoming. Because of our very dry atmospheric conditions in Wyoming, most of these foliar treatments are rarely needed. Waiting periods, precautions and limitations vary with different chemicals, and the label of each product should be read completely before use.

a. Beans -- Rust

Captan
Chlorothalonil (Bravo^R)
Copper oleate
Copper sulfate
Nabam
Sulfur
Zineb

b. Corn -- Southern corn leaf blight

Zinc ion-maneb complex (Do not apply within 40 days of harvest.)
Zineb (Do not feed treated forage or husks to dairy animals being finished for slaughter. No time limitation.)

c. Potatoes and tomatoes -- Early blight and late blight

Many different fixed copper fungicides
Amobam^K
Anilazine (Dyrene^R)
Captan
Chlorothalonil
Dithane M-45
Maneb
Polyram
Several others

d. Apples, crabapples, cotoneaster, mountain ash and pears -- Fire blight

Combine all spray treatments with pruning out of diseased wood. Sterilize pruning tools in sodium hypochlorite (laundry bleach) (1 part bleach to 4 parts water) between cuts.

Several fixed coppers
Streptomycin
Zineb

e. Apples -- Scab

Benomyl

Dichlone
Dodine (Cyprex^R)
Glyodine
Sodium dimethyldithiocarbamate

f. Apples -- Cedar-apple rust

Captan
Ferbam
Maneb
Manzate 200^R
Nabam
Polyram
Sodium dimethyldithiocarbamate
Sulfur
Thiram
Zineb

g. Ornamentals, shrubs and trees

Botrytis blight

Captan
Maneb
Benlate

Leaf Spots

Benomyl (Benlate^R)
Bordeaux Mixture
Captan
Fixed coppers
Maneb
Folpet (Phaltan^R)
Zineb
Ziram

Powdery mildews

Benomyl
Dinocap (Karathane^R)
Sulfur

Wound dressings to prevent wood decay

Copper naphthenate in asphalt
Copper sulfate (basic) with phenol
Sodium phenylphenate tetrahydrate paste
Thiram in a paint with asphalt

- h. Vegetables and fruits (general) -- Available broad-spectrum foliage chemicals are not effective in all cases. Read labels to see which specific chemicals apply to your specific needs.

The following chemicals have been cleared for a wide variety of vegetables and fruits.

Anilazine (Dyrene^R)

Botran

Captan

Chlorothalonil

Dicloran (Botran^R)

Ferbam

Fixed coppers

Folpet

Maneb

Polyram

Zineb

Ziram



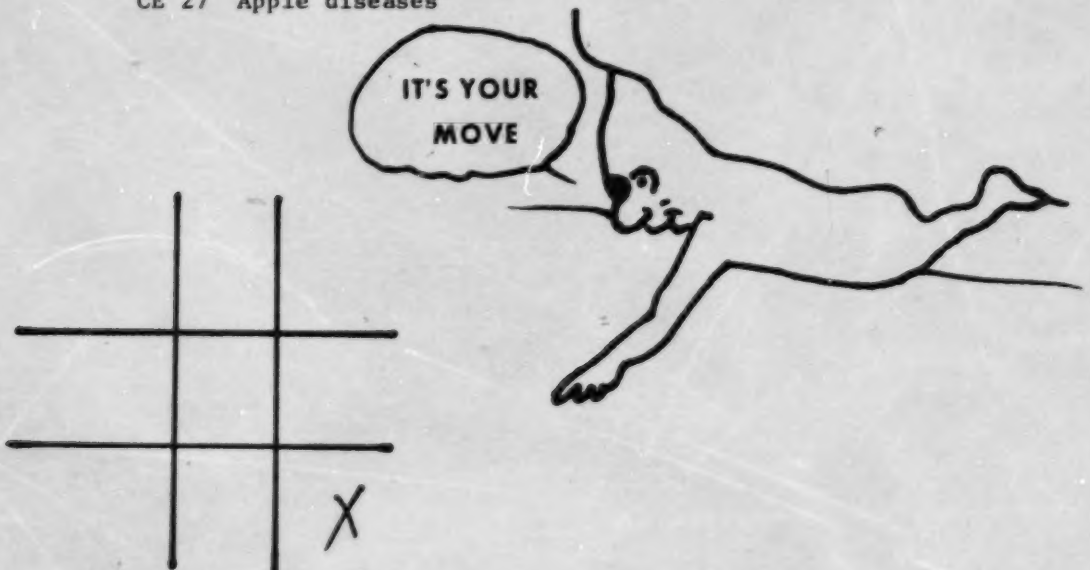
ARE YOU SURE IT'S A FUNGUS

SECTION VII

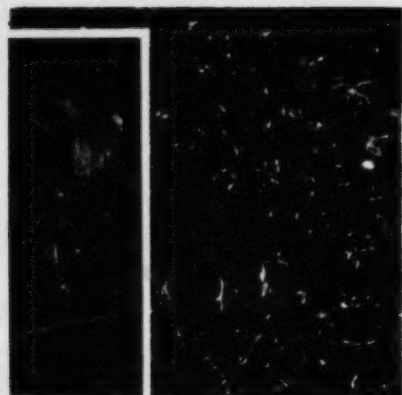
Plates of Symptoms and Signs

The following plates purchased from Clemson University and prepared by the Clemson Agricultural Extension Service, Plant Pathology and Agricultural Communications Sections are used to aid in the study of plant diseases and grateful acknowledgement is hereby made. Many of the diseases illustrated do not represent Wyoming diseases on Wyoming crops but are considered helpful from the standpoint of disease identification.

- CE 3 Some common vegetable diseases
- CE 6 Cucurbit diseases
- CE 8 Vegetable diseases, II
- CE 13 Small grain diseases
- CE 14 Ornamental diseases
- CE 17 Corn diseases
- CE 18 Shade and forest tree diseases
- CE 27 Apple diseases



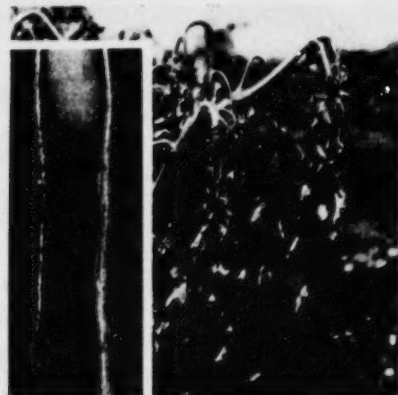
SOME COMMON VEGETABLE DISEASES



1. FUSARIUM WILT OF TOMATOES AND CROSS SECTION OF STEM



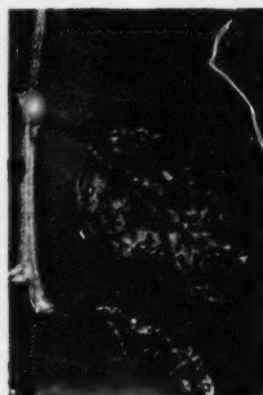
2. SOUTHERN BLIGHT OF TOMATO



3. BACTERIAL WILT OF TOMATO WITH CUT SECTION OF STEM



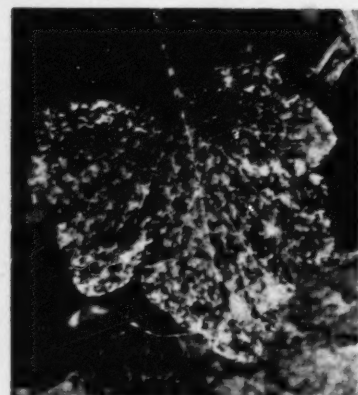
4. EARLY BLIGHT OF TOMATO ON LEAF AND STEM



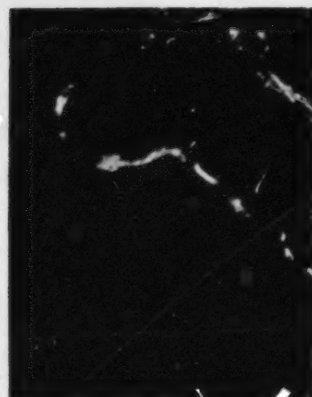
5. GRAY LEAF SPOT ON TOMATO LEAFLETS



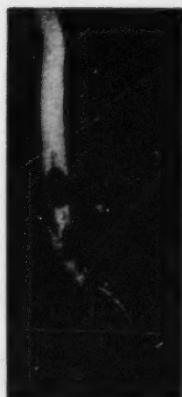
6. CORN SMUT



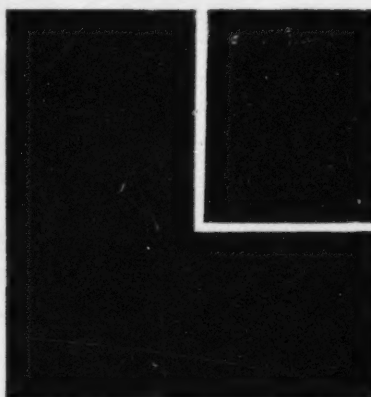
7. POWDERY MILDEW ON LEAF



8. ROOT KNOT NEMATODE GALLS ON ROOTS



9. STEM LESION ON BEAN



10. DOWNY MILDEW, UPPER AND LOWER LEAF SURFACE

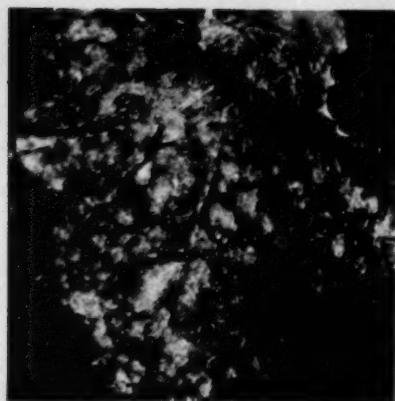


11. SQUASH FRUIT ROT

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

CUCURBIT DISEASES

An Aid to Identification and Control



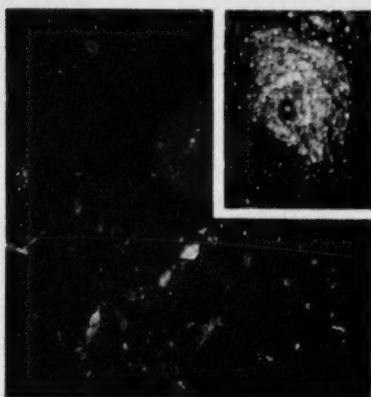
1. POWDERY MILDEW OF CANTALOUPE



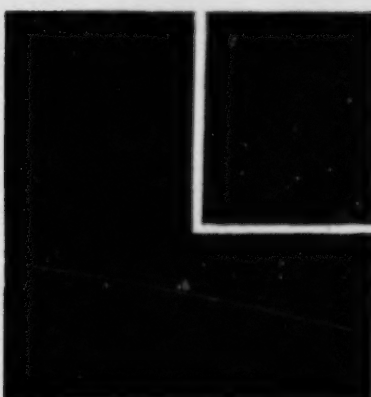
2. SCAB OF SQUASH



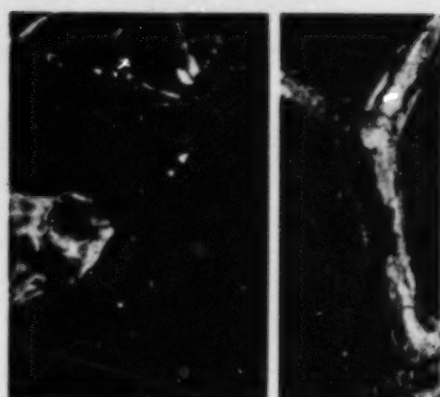
3. ANTHRACNOSE OF WATERMELON
Insets show stem and melon damage



4. ALTERNARIA BLIGHT OF CANTALOUPE
Inset shows closeup of leaf spot



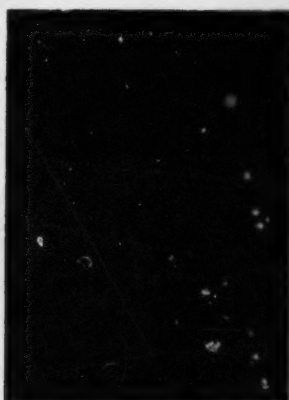
5. DOWNY MILDEW OF CANTALOUPE
Inset shows upper leaf surface



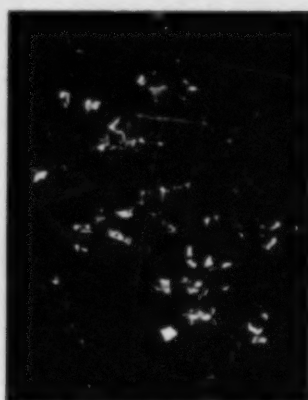
6. GUMMY STEM BLIGHT ON LEAF AND STEM



7. FUSARIUM WILT OF WATERMELON STEM



8. ANTHRACNOSE OF CUCUMBER



9. ANGULAR LEAF SPOT OF CUCUMBER

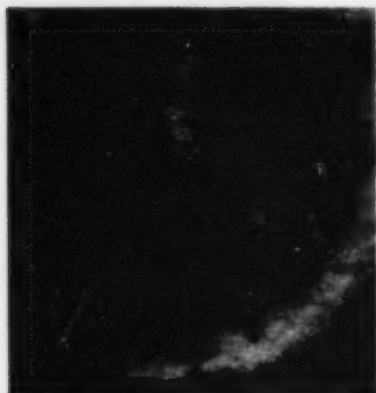


10. BELLY ROT OF CUCUMBER

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

VEGETABLE DISEASES, II

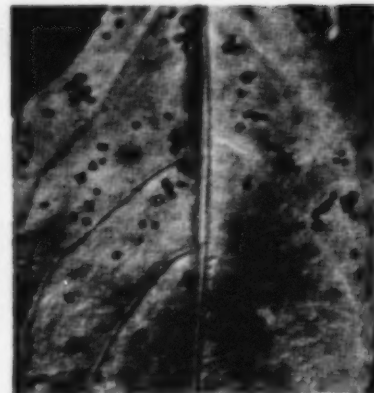
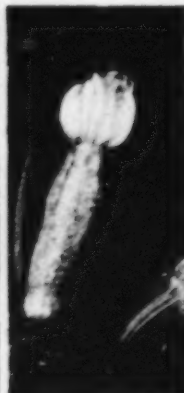
An Aid to Identification and Control



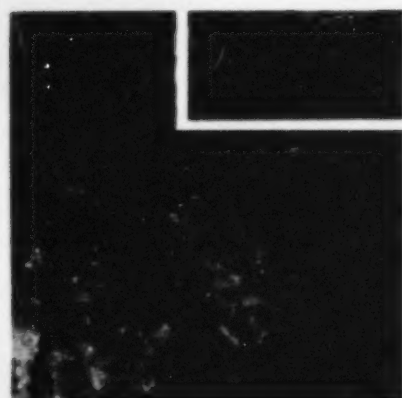
1. STEM ANTHRACNOSE OF LIMA BEAN



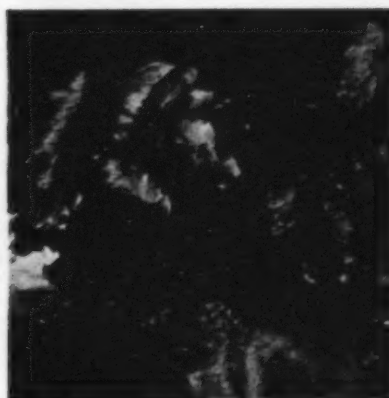
2. SQUASH MOSAIC ON LEAF AND YOUNG FRUIT



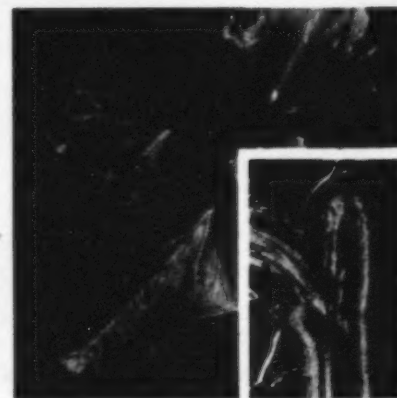
3. BACTERIAL SPOT OF PEPPER



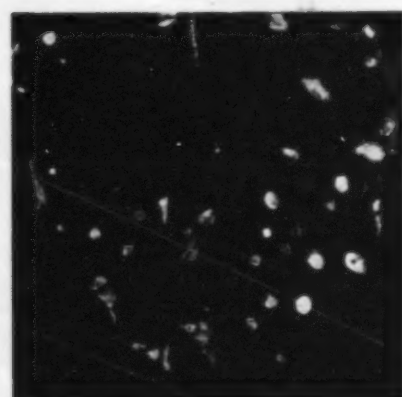
4. DOWNY MILDEW OF CABBAGE
Inset shows *Alternaria* following damage



5. LETTUCE DROP



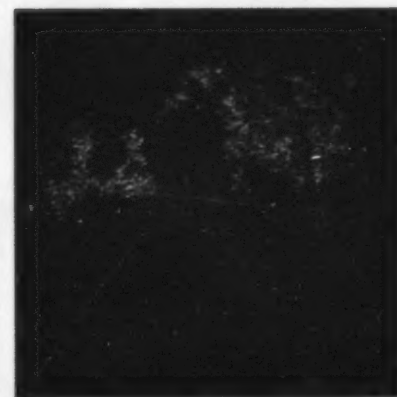
6. FUSARIUM WILT OF SWEET POTATO
Inset shows stem damage



7. WHITE LEAF SPOT OF TURNIP



8. RUST OF SNAPBEAN

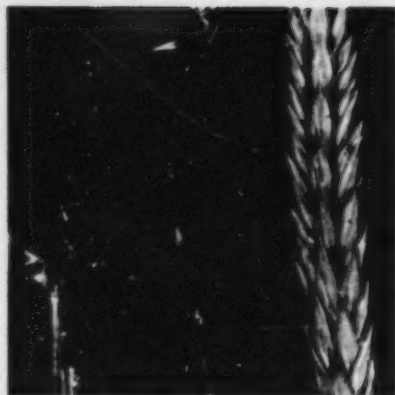


9. SCAB OF IRISH POTATO

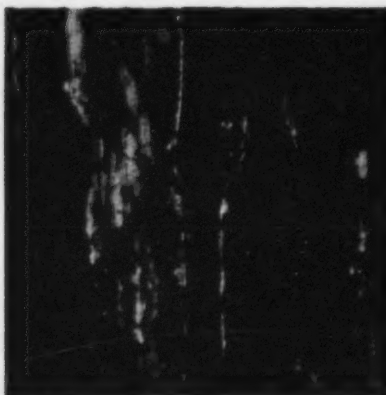
PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

SMALL GRAIN DISEASES

An Aid to Identification and Control



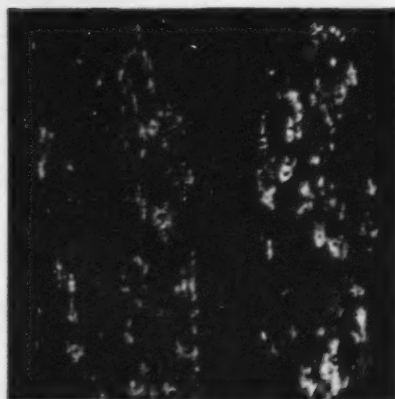
1. LOOSE SMUT OF BARLEY



2. SCALD DISEASE OF BARLEY



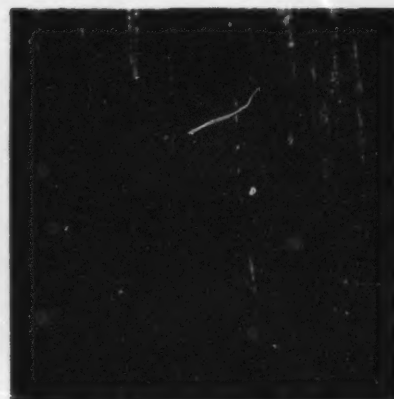
3. ANTHRACNOSE OF RYE



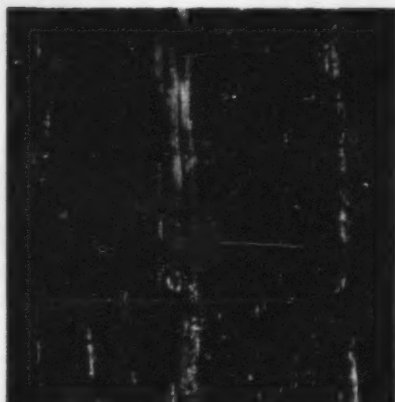
4. POWDERY MILDEW



5. SOIL-BORNE MOSAIC OF OATS



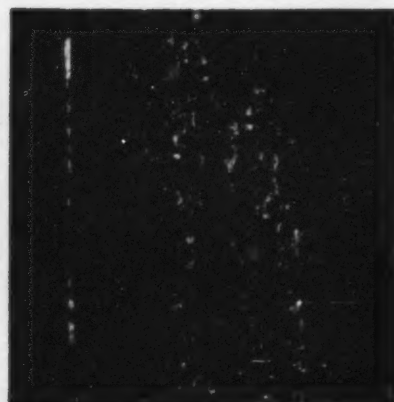
6. LEAF STRIPE OF BARLEY



7. HELMINTHOSPORIUM LEAF SPOT
OF OATS



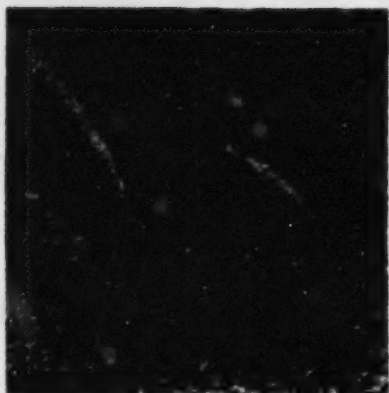
8. SEPTORIA LEAF SPOT OF WHEAT



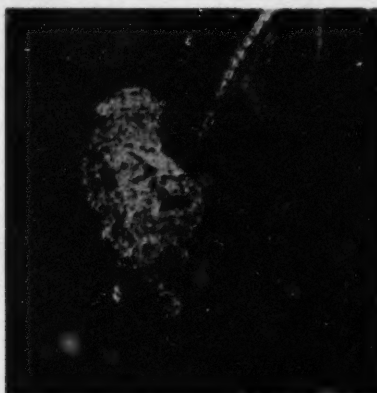
9. LEAF RUST

ORNAMENTAL DISEASES

An Aid to Identification and Control



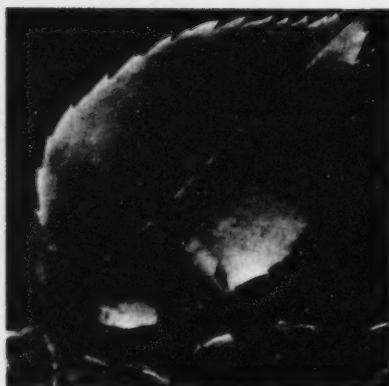
1. DAMPING-OFF OF SEEDLINGS



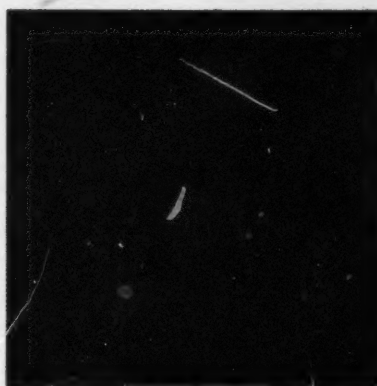
2. AZALEA LEAF GALL



3. CAMELLIA FLOWER BLIGHT



4. BLACK SPOT OF ROSE



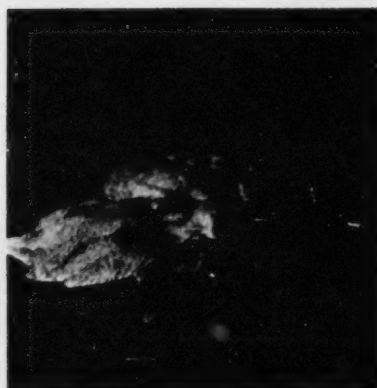
5. IRIS LEAF SPOT



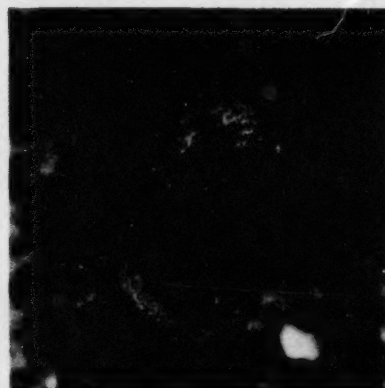
6. POWDERY MILDEW OF PHOTINIA



7. FIRE BLIGHT OF TULIP



8. LEAF SPOT OF CHRYSANTHEMUM



9. DIEBACK OF CAMELLIA

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

CORN DISEASES

An Aid to Identification and Control



1. BROWN SPOT



2. HELMINTHOSPORIUM LEAF SPOT



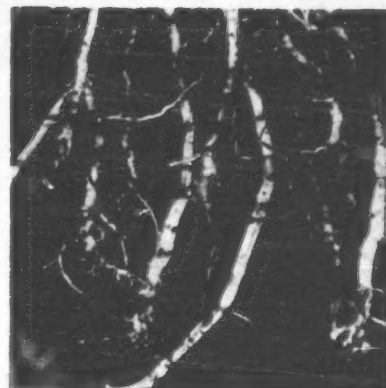
3. VIRUS DISEASE



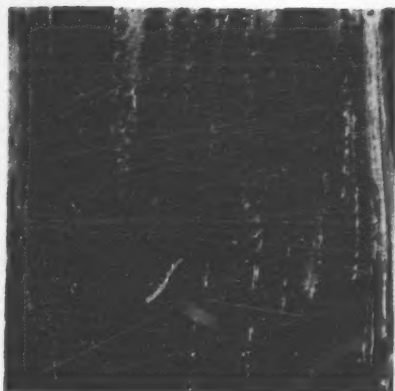
4. SMUT



5. EAR ROT



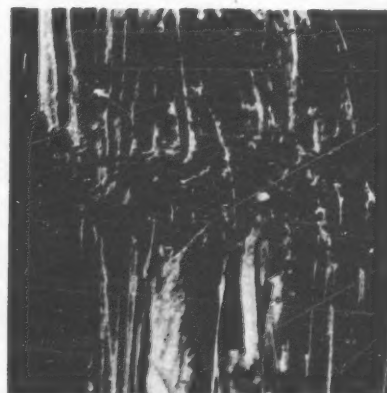
6. NEMATODE DAMAGE TO ROOTS



7. CHARCOAL STALK ROT



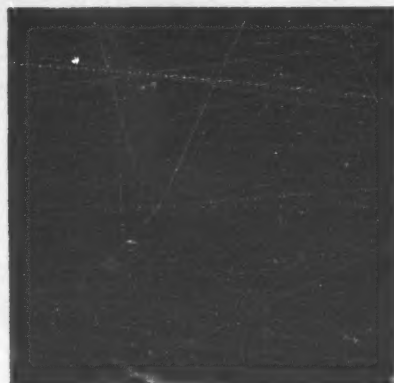
8. STALK ROT AND LODGING



9. FUSARIUM STALK ROT

SHADE AND FOREST TREE DISEASES

An Aid to Identification and Control



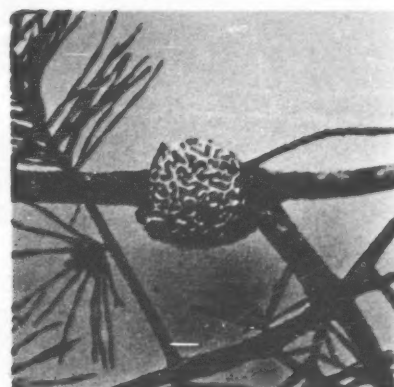
1. OAK LEAF BLISTER



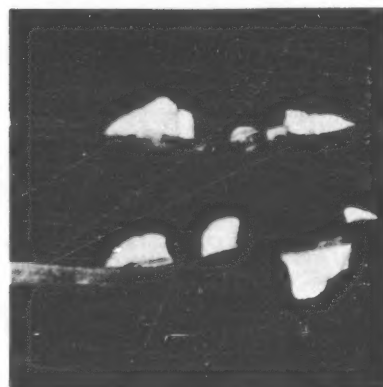
2. POWDERY MILDEW



3. ANTHRACNOSE ON SYCAMORE



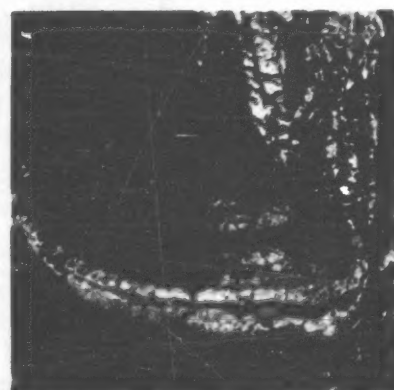
4. EASTERN GALL RUST OF PINE



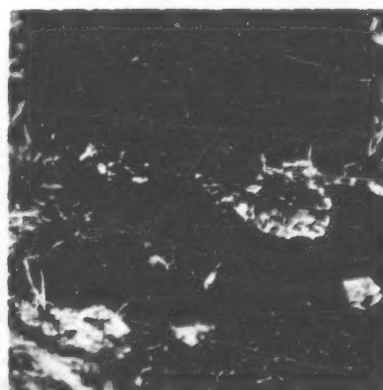
5. PINE NEEDLE RUST



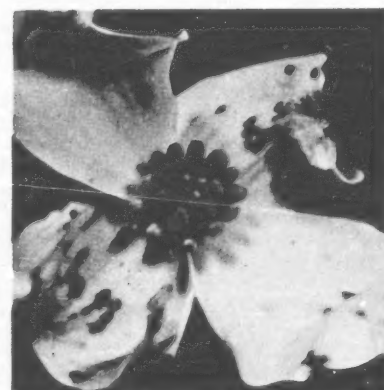
6. LITTLE LEAF OF PINE



7. FRUITING STRUCTURE OF THE
HEART ROT FUNGUS



8. FRUITING STRUCTURE OF THE
FOMES ROOT AND BUTT ROT
FUNGUS

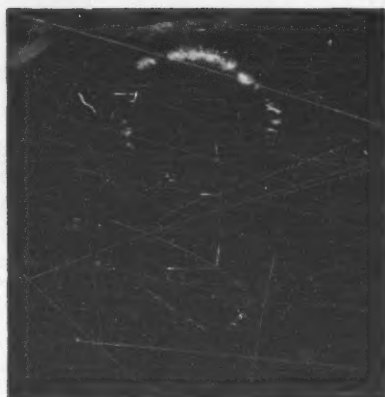


9. ANTHRACNOSE OF DOGWOOD

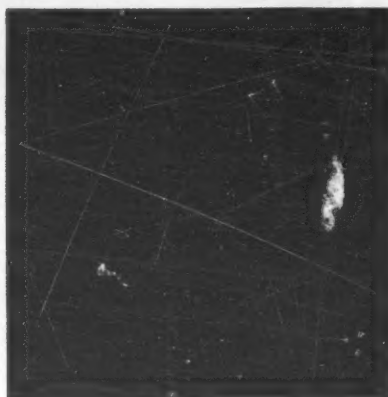
PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

APPLE DISEASES

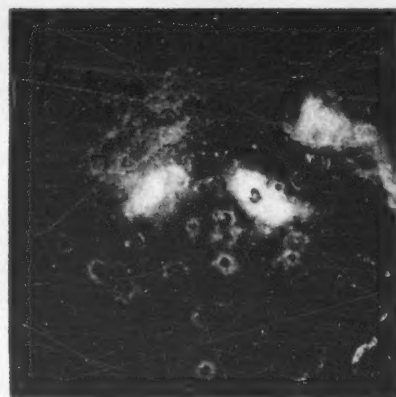
An Aid to Identification and Control



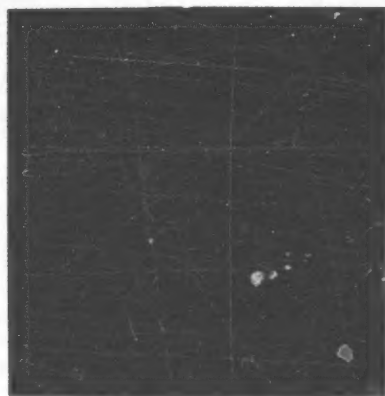
1. BLACK ROT ON FRUIT



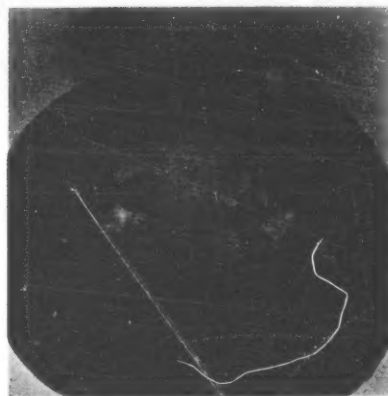
2. BITTER ROT ON FRUIT



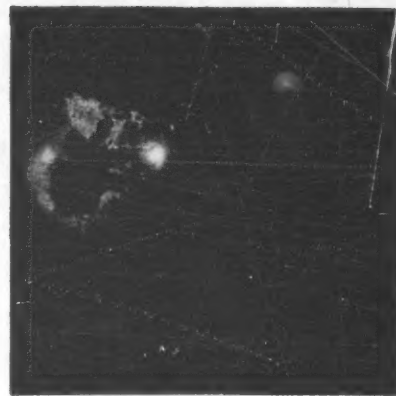
3. SCAB ON FRUIT



4. BLACK ROT ON MUMMY AND FROG-EYE STAGE ON LEAF



5. SOOTY BLOTCH AND FLYSPECK DAMAGE TO FRUIT



6. SCAB ON FRUIT AND LEAF



7. POWDERY MILDEW



8. CEDAR-APPLE RUST



9. FIRE BLIGHT

SECTION VIII

Plant Pathology Glossary

Anthracnose - Term describing a disease having characteristic lesions and commonly caused by a member of the Melanconiales.

Atrophy - A lack of development in certain parts or tissues.

Bactericide - Material that will kill bacteria.

Bacterium (bacteria) - A microscopic, unicellular plant, lacking chlorophyll and reproducing by simple cell division.

Canker - A diseased or dead area in the bark and wood of trees or shrubs. Characterized by a drying out of the tissues. Often in cortical areas.

Cell - The unit of plant and animal structure, consisting of a small bit of protoplasm which in plants is usually surrounded by a cell wall.

Cortical - Of or pertaining to the cortex.

Damping-off - A type of seedling disease in which the stem decays in the vicinity of the soil line.

Ecology (applied to plant pathology) - The study which deals with the effect of environmental factors, such as soil, climate, and culture on the occurrence, severity, and distribution of plant diseases.

Environment - The external conditions and influences surrounding living organisms.

Exudate - Material that has been forced out.

Fungal - Relating to fungi.

Fungicide - Material that will kill fungi.

Fungus (fungi) - A thallus plant (i.e., one not differentiated into root, stem and leaves), devoid of chlorophyll. (In a general sense)

Gall - An unusual enlargement on some portion of a plant.

Host - The plant or animal upon which a parasite lives.

Hyperplasia - An abnormal development of tissues due to an increase in the number of cells (see hypertrophy).

Hypertrophy - An abnormal development of tissues due to an increase in the size of individual cells.

Hypha (hyphae) - One of the filaments which collectively form the mycelium of a fungus.

Hypoplasia - Under development of growth or multiplication.

Incubation period - The period between the time the inoculum is introduced onto the host and the time when the diseased condition becomes macroscopically evident.

Infection - The process of gaining entrance and becoming established as a parasite.

Infection court - Specific area on plant where a pathogen gains entrance to the host.

Infest - To overrun.

Inoculum - That portion of a pathogen which is transferred to a host. It usually consists of spores, bacteria, or mycelial fragments.

Inoculation - The process of transferring inoculum to host.

Lesion - A diseased region.

Life History - The succession of developmental stages in the life of an organism from its beginning until it disappears through natural death, or by division reproduces itself.

Local invasion - That involving only a localized area of the plant. (See systemic invasion).

Mummy - A dried, diseased fruit.

Mycelium - Collective term for a group or mass of hyphae or fungous filaments.

Necrosis - A type of pathological condition marked by the rapid destruction of cell structures and a consequent prompt death of the protoplasts.

Nematocide - A material that will kill nematodes.

Obligate - Necessary; essential; (of parasitism) necessarily parasite; capable of living only as a parasite; (cf. facultative).

Obligate parasite - Organisms that can live only as parasites.

Obligate saprophyte - Organisms that can live only as saprophytes.

Pathogen(e) - A disease-producing agent. Usually an organism.

Pathogenicity - Ability of an organism to produce disease.

Pathology - The study of, or a discourse on disease.

Pesticide - A material that will kill or control pests.

Physiology. The study of processes, activities and phenomena related to life.

Pustule - A pimple-like to blister-like elevation.

Rogue - Remove; pull out.

Rust - Originally, the summer or uredinial stage of the Uredinales on grasses; now used either for the fungus itself in any of its stages or the disease caused by any of the stages.

Saprophyte - An organism growing on dead organic matter, or taking its nutrition from inorganic materials.

Sclerotium (sclerotia) - A hard, dense, compact mass of mycelium serving as a resting body.

Secondary infections - Those infections initiated (usually during the summer) by inocula from primary or other secondary infections without an interposed resting or dormant period.

Sign - The structure of the pathogen itself.

Spore (in the fungi) - A seed-like structure formed by mycelium and serving as an agent of propagation.

Stomata (stoma) - Small openings or pores on the surface of leaves or stems.

Symptom - Something that indicates diseased condition.

Tumor - A swelling or protuberance.

Virulent - Highly pathogenic.

Vector - An animal able to transmit a pathogen.

SECTION IX

References

1. Agrios, G. N. 1969. Plant Pathology. Academic Press. New York. pp. 629.
2. American Phytopathological Society. 1973. A compendium of corn diseases. American Phytopathological Soc. St. Paul. pp. 64.
3. Berg, Gordon L. (ed.). 1972. Master Manual on Mold and Mycotoxins. Farm Technology/Agr. Fieldman. Fall. pp. 1-67a.
4. Bridgmon, G. H. 1958. Plant Pathology. A Manual of Western Plant Diseases. Rev. 1971. Pvt. Print. pp. 142.
5. Carlstrom, R. C. 1971. Chemical Seed Treatments. Montana State Univ. Agr. Ext. Bull. 1085. pp. 24.
6. Colorado State University. 1973. 1973 Guide to Chemical Control of Plant Diseases in Colorado. CSU Gen. Series 930. pp. 60.
7. Environmental Protection Agency. No date. Compendium of Registered Pesticides. Vol. II. Fungicides and Nematocides. Regulations Div. Washington, D. C. Published EPA (In Press)
8. King, C. L. and W. G. Willis. 1973. Kansas Pesticide Users Handbook. Section VI. Fungicides and Nematocides. pp. F1-41.
9. Maloy, O. C. 1971. Washington Pest Control Handbook. Chapter 15. Plant Diseases, pp. 419-464. Washington State Univ. & State Dept. of Agr.
10. Moller, W. J., D. H. Hall, A. T. L. McCain and A. O. Paules. 1972. Study Guide for Agr. Pest Control Advisors on Plant Diseases. Univ. of Calif. Div. of Agr. Sciences. pp. 232.
11. National Academy of Sciences. 1968. Principles of Plant & Animal Pest Control. Vol. I. Plant Disease Development and Control. Nat. Acad. of Sci. Washington, D. C. pp. 205.
12. Pirone, P. P. 1970. Diseases and Pests of Ornamental Plants. The Ronald Press Co. New York. pp. 546.
13. Plank, J. E. van der. 1963. Plant Diseases. Epidemics and Control. Acad. Press. New York. pp. 349.

14. Roberts, D. A. and C. W. Boothroyd. 1972. Fundamentals of Plant Pathology. W. H. Freeman & Co. San Francisco. pp. 402.
15. Streets, Rubert B., Jr. 1969. The Diagnosis of Plant Diseases. Ariz. Agr. Ext. Serv. Univ. of Ariz. Tucson, Ariz. n.p.
16. Tarr, S. A. J. 1972. Principles of Plant Pathology. Winchester Press. London. pp. 632.
17. Torgeson, D. C. (ed.). 1967-9. Fungicides, An Advanced Treatise. Vol. I. Agricultural and Industrial Applications, Environmental Interactions. 1967. pp. 697. Vol. II. Chemistry and Physiology. 1969. pp. 742. Acad. Press. New York.
18. United States Dept. of Agriculture. 1969. Annotated Index of Registered Fungicides and Nematocides; Their Uses in the United States. Constantly revised by Pesticides Regulations. Dir. of Agr. Res. Serv. Washington, D. C. Loose leaf n.p.
19. Walker, J. C. 1952. Diseases of Vegetable Crops. McGraw-Hill Book Co. New York. pp. 529.
20. Walker, J. C. 1969. Plant Pathology. 3rd Ed. McGraw-Hill Book Co. New York. pp. 819.
21. Westcoff, Cynthia. 1950. Plant Disease Handbook. D. VanNostrand Co., Inc. New York. pp. 746.